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Abstract:
Hall's (1988) approach to study price-cost margins is adapted to simultaneously estimate price-cost margins and scale economies from a panel of plant level data. The paper shows how this methodology provides a very flexible framework with only a few, economically interesting parameters to be estimated. The econometric model is tested and estimated on different panels of plants, covering most manufacturing industries in Norway 1980-90. The GMM-estimates suggest significant, but quite small, markups in all industries. No industry exhibits increasing returns to scale; the average firm (in all industries) seems to face constant or moderately decreasing returns to scale. Estimates suggest that there is more variation in the price-cost margins and scale coefficients within the fairly narrow industry groups investigated, as compared to between the industry groups.

* This paper is a substantially revised version of Klette (1993).

Keywords: Market power, scale economies, GMM, specification testing, establishment data.

JEL classification: D40, C23

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1 Introduction

The theoretical literature on the nature and consequences of imperfect competition and scale economies grows rapidly throughout the field of economics. Still, the appropriate methodology to study the empirical significance of scale economies and price-cost margins remains an unsettled issue in econometrics, despite its long history[1]. This paper presents a new econometric framework - inspired by Hall (1988, 1990) - to simultaneously estimate price-cost margins and scale economies using a panel of firm or establishment data[2]. I have applied the framework to study market power and scale economies in a comprehensive panel of manufacturing establishments. The framework presented in this paper is also well-suited to examine productivity differences between firms and their causes[3].

In his pioneering work, Hall (1988, 1990) has recently provided evidence of substantial market power and scale economies in US manufacturing[4]. Hall's results were based on a new approach to the estimation of price-cost margins and scale economies. Notice that Hall estimated price cost margins and scale economies *separately*, and somewhat inconsistently. In his studies of *price cost margins*, Hall kept constant return to scale as a maintained hypothesis. Bresnahan (1989) and Chirinko and Fazzari (1994) among others, have emphasized the criticism that Hall measures marginal costs from incremental labor costs, without considering the possibility of (long-run) scale economies and quasi-fixed factors. The present paper shows how Hall's framework can be extended to account for scale economies and the quasi-fixity of capital. The analysis also incorporates the cost contribution of material inputs, as has been done by Domowitz et al. (1988) and others.

When estimating price cost margins, it is of course essential to adjust for scale economies, as the estimate of scale economies will tend to be tightly linked to the estimate of the ratio of price and marginal costs. For instance, with price and average costs as the observable point of departure, overestimating the scale economies will imply underestimated marginal costs, providing an overestimated price-marginal cost ratio. Considering the large order of magnitude of

[1]See Bresnahan (1989) for a survey of the econometric literature on the estimation of market power. Panzar (1989) discusses the estimation of scale economies.

[2]Hall's methodology has mainly been applied to industry level and aggregate data. However, see also Levinsohn (1993) and Harrison (1994).

[3]See Klette (1994) and Simpson (1994).

[4]Following Hall's research, a number of studies have applied his approach to industry level data. See Norrbin (1993) and the references cited there.

Hall's estimate of scale economies, keeping constant returns as a maintained hypothesis in his study of price cost margins questions the consistency of the estimates.

In his analysis of *scale economies*, Hall did not explicitly consider deviations between price and marginal costs. Instead, he relied on a user cost formula for capital to infer the shadow price of capital from dividend yields, effective tax rates, depreciation rates and deflators derived from prices on new investment goods. In this way, Hall bypassed the issue of market power in the study of scale economies. The present study avoids imposing the strong assumptions required to infer the marginal product of capital from the observables used by Hall. In my framework, the shadow price is estimated, simultaneously with the rest of the model, as a residual share adjusted for the presence of scale economies and price-cost margins. This approach captures situation where the capital stock adjusts sluggishly, thereby creating persistent deviations between temporary and long run equilibrium behavior.

Hall used macro and industry level data in his studies of price-cost margins and scale economies. Most subsequent research has also used macro and industry level data[5]. But micro level data are essential for a simultaneous study of price-cost margins and scale economies, since scale economies at the industry level are affected by externalities[6], entry and exit, phenomena that have little to do with the scale economies relevant for the firms' price setting decisions. The use of plant or firm level panel data has some other benefits. The model can be implemented at the level for which it is constructed, thereby eliminating the well-known and important problem of aggregation and the need to resort to the notion of the representative firm. In the present study, I allow for permanent productivity differences between firms (by "fixed effects"). Such differences are known to be present in most data sets on firms, and their presence questions the validity of results from aggregate data that are based on the notion of a representative firm.

The scale coefficients presented in this paper incorporate changes in both variable factors (materials, energy and working hours) and the quasi-fixed capital variable, and are in this sense long-run scale elasticities. But the approach focuses on *changes* in the level of operation in the time-series dimension, and disregards the cross-sectional information about efficiency differences in small versus large plants[7]. Some people might argue that the last comparison is more relevant

[5]See references cited in footnote 2 for recent exceptions.

[6]Bartelsman et al. (1991) interpret Hall's scale estimates in terms of external economies.

[7]In the jargon from the panel data literature: I focus on estimates from first differences, and neglect the "between" variation.

to understand long-run scale economies. But the comparison in efficiency between small and large plants raises the question of causality: Are large plants more efficient because they are large (which would support claims about scale economies), or have they grown larger than other plants because they are more efficient (due to e.g. better technology or better management)[8]? This question raises doubt about whether cross-sectional differences in efficiency can be interpreted as evidence on scale economies[9].

The use of panel data permits a flexible parameterization of technological change. Hall assumes that technological change can be represented by a time trend and a white noise term over the entire period 1953-1984. Given economists' perception of productivity growth before and after the oil price shocks, this assumption seems questionable (in particular given that one of Hall's instrumental variables is the oil price). The model presented in this paper allows technological change at the industry level to develop from one year to another without parametric constraints. A related advantage of my panel data model is that it does not depend on outside deflators. This is comforting since input and output deflators for many industries are unreliable not least due to the problems of dealing with quality changes.

The empirical model is implemented on a comprehensive panel of establishment data covering most of Norwegian manufacturing over the period 1980-90. The data set permits extensive testing of the validity of the econometric model. The preferred estimates reveal significant market power in a clear majority of the 14 industries considered. But the price-cost margins are small compared to Hall's findings. Most of the margins belong to the interval 5-10 percent. The results show little evidence of scale economies. None of the industries reveal estimates of the scale elasticity above one, while most of the industries appear the face moderate decreasing returns to scale. These findings refer to the average price-cost margins and scale elasticities within each industry.

It is likely that the price-cost margins and scale coefficients vary, perhaps substantially, within each of the industries considered. To examine this issue, the analysis adopts a somewhat new random coefficient framework that allows for differences in market power and scale economies within each industry. My estimates reveal more variation in market power and scale economies

[8]This issue was raised in the empirical production function literature by Marschak and Andrews (1944). The controversy, raised by Demsetz (1974) and others, in the theoretical I.O.-literature on whether concentration is desirable or not, has also emphasized this point.

[9]The differences between cross sectional and panel data studies of production functions is an old and extensively discussed issue. See e.g. Ringstad (1971), Mundlak (1978) and Mairesse (1990).

within an average industry, as compared to variations between industries. Still, the variations in these parameters within an average industry are quite small.

The framework put forward below is an endeavor to relax some of the rigid assumptions imposed on the production relationships in traditional production function studies. Mairesse and Griliches (1990) found substantial heterogeneity and instability in the coefficients of their estimated production functions for US, French and Japanese firms. Motivated by this finding, the model presented in the current paper is consistent with an unconstrained pattern of technological change over time. Also, in the cross-sectional dimension, I have used a flexible approximation to model the technological constraints. Rather than using rigid functional forms, the study relies on the validity of first order conditions to infer the marginal productivities for the variable factors of production[10]. The model is consistent with differences between firms in their factorprices. The framework is also more flexible than most panel data models using production or cost functions, in that capital is treated as a quasi-fixed factor with a shadow price that might differ across observations, and from the (long-run equilibrium) user cost of capital. The variances of the productivity term and the scale elasticity are found to be between one and two orders of magnitude smaller than the corresponding coefficients estimated by Mairesse and Griliches (1990). That is, the random coefficients in the model put forward in this paper are less dispersed than the coefficients in standard production functions.

Section 2 spells out the theoretical framework. Section 3 presents the construction of the applied sample. Stochastic assumptions, specification testing and other econometric issues are considered in section 4. The empirical results are presented and discussed in section 5. Section 6 provides the analysis of parameter heterogeneity. Section 7 gives some additional comments.

2 The theoretical model

The theoretical framework presented here imposes only a minimal set of restrictive assumptions about functional forms and behavior. The firms within an industry are assumed to be constrained by a production function $Q_{it} = A_{it}F_t(X_{it})$. Q_{it} and X_{it} represent output and a vector of inputs

[10]The idea of inferring the output elasticity of labor from the first order conditions is not new. It dates back to the original work on production functions by Cobb and Douglas. The use of this relationship in the estimation of the scale elasticity is attributed to Klein (1953) by Griliches and Ringstad (1971). Griliches and Ringstad (1971), and Ringstad (1971, 1978), used this approach extensively in their analysis of scale economies in Norwegian manufacturing.

for establishment i at year t. A_{it} is a productivity factor. $F_t(\cdot)$ is the production (or aggregation) function common to all firms in a given year. The time subscript on this function indicates that the function can change freely from one year to the next.

Using a version of the multivariate, generalized mean value theorem[11], the production function relationship can be expressed in terms of logarithmic deviations from a point of reference. That is to say, the production function relationship can be rewritten

$$\hat{q}_{it} = \hat{a}_{it} + \sum_{j \in M} \bar{\alpha}^j_{it} \hat{x}^j_{it}, \tag{1}$$

where

$$\bar{\alpha}^j_{it} \equiv \frac{X^j_{it}\, \partial F_t(X_{it})/\partial X^j_{it}}{F_t(X_{it})}\Big|_{X_{it}=\bar{X}_{it}} \quad \forall j \in M. \tag{2}$$

In (1), a lower case letter with a hat is the logarithmic deviation from the point of reference of the corresponding upper case letter. E.g., $\hat{q}_{it} \equiv \ln(Q_{it}) - \ln(Q_t)$, where Q_t represents the reference point. (In the empirical application, this reference point has been chosen as the time specific median value of output within the industry). A similar (time-industry) median value is used as a reference point for each of the inputs. I will denote this reference vector for the inputs by $X_t = \{X^1_t, X^2_t, \cdots, X^m_t\}$. M denotes the set of (the m) inputs. The production function $F_t(\cdot)$ and its partial derivatives on the right hand side of (2) are evaluated at an internal point $(\bar{X}_{it})$ between X_{it} and the reference point X_t [12]. I use the notation that a bar over a factor such as α^j_{it} indicates that it is evaluated at an internal point.

Let me emphasize the motivation behind the use of a mean value theorem rather than a first or second order Taylor approximation in the derivation above. In the *cross sectional* dimension in an industry, relative differences in, say, output can be of the magnitude of several hundred percent. Such large differences would undermine the argument for truncating a Taylor approximation after the first order term (or at any finite order for that matter). The model derived by using the mean value theorem is *a priori* suitable for samples with any size of the relative differences (not only small values for $\hat{q}_{it}, \hat{a}_{it}$ and $\hat{x}^j_{it}$). This is important when the model

[11] Cf. Berck and Sydstæter (1991), p. 11. for a statement of the generalized mean value theorem. The extension to the multivariate case is straight forward, as suggested in e.g. Thomas (1968, p.545).

[12] More precisely, the point $(\bar{X}_{it})$ belongs to the domain spanned by the coordinates $\{X_{it}\ , (X^1_t, X^2_{it}, X^3_{it} \cdots, X^m_{it})\ , (X^1_{it}, X^2_t, X^3_{it} \cdots, X^m_{it})\ , \cdots (X^1_{it}, X^2_{it}, X^3_{it} \cdots, X^m_t)\ , X_t\}$. Cf. e.g. Thomas (1968, p.545).

is applied to capture cross sectional variations, say, in output, based on a sample of firms or plants.

According to basic producer theory, profit maximizing behavior requires that marginal costs should be equal to the marginal revenue product. I assume that the firm is a price taker in the input markets, while allowing for the possibility of imperfect competition in the output markets. Notice that such an assumption is perfectly consistent with a bargaining situation where the firm and the union bargain over the wage rate, while the firm unilaterally determines the number of hours employed[13]. It follows that

$$A_{it}\frac{\partial F_t(X_{it})}{\partial X_{it}^j} = \frac{W_{it}^j}{(1-1/\varepsilon_{it})P_{it}} \tag{3}$$

where W_{it}^j is the factor price for input j.

P_{it} is the price of output, while ε_{it} is the (conjectured) price elasticity of demand[14]. According to the theory of imperfect competition, the factor $1/(1-1/\varepsilon_{it})$ represents the ratio of price and marginal costs. Denoting this price-cost ratio (or markup) by μ_{it}, and using the set of first order conditions in equation (3), we have that

$$\begin{aligned} \bar{\alpha}_{it}^j &\equiv \frac{X_{it}^j\, \partial F_t(X_{it})/\partial X_{it}^j}{F_t(X_{it})}\Big|_{X_{it}=\bar{X}_{it}} \\ &= \mu_{it}\,\frac{\bar{W}_{it}^j \bar{X}_{it}^j}{\bar{P}_{it}\bar{Q}_{it}} \\ &= \mu_{it}\,\bar{s}_{it}^j, \end{aligned} \tag{4}$$

where $\bar{s}_{it}^j$ is the cost share of input j relative to total revenue. Clearly, the relationship in (4) only tends to hold on average (in some sense), and is not expected to hold for each firm in each period. Discrepancies could be due to unobserved costs (i.e. not reported in the data) and uncertainty in factors prices and demand facing the firms[15]. Hence, it is natural to allow for some noise (e_{it}^j) in the relationship:

[13]Nickell et al. (1991) presents an elaborate discussion of this point.

[14]This price elasticity should be interpreted in a broad sense, incorporating the "conjectured price and quantity responses" of the competitors. Bresnahan (1989) has emphasized the generality of this formulation in empirical work.

[15]Uncertainty about productivity shocks presents more subtle problems (see Zellner et al., 1966). See also Eden and Griliches (1993), who examine some implications of demand uncertainty for empirical production analysis.

$$\bar{\alpha}_{it}^{j} = \mu_{it}\ \bar{s}_{it}^{j} + e_{it}^{j} \tag{5}$$

In the next section, I will specify the stochastic properties of the noise term.

Various rigidities make it dubious to assume that (4) holds for capital, i.e. to impute the marginal product of capital from observed prices on new equipment, tax rules, interest and depreciation rates. For a competitive industry with constant returns to scale, it is now standard practice to handle this problem by estimating the shadow price, and thereby the factor share of capital, residually. This approach can easily be extended to cases with imperfect competition and non-constant returns to scale[16]. The elasticity of scale in production is defined by

$$\bar{\eta}_{it} = \sum_{j \in M} \bar{\alpha}_{it}^{j}. \tag{6}$$

Using (5), it follows that

$$\bar{\alpha}_{it}^{K} = \bar{\eta}_{it} - \sum_{j \neq K} (\mu_{it}\bar{s}_{it}^{j} + e_{it}^{j}) \tag{7}$$

Notice that the capital share, as constructed in (5), will vary across establishments and over time. If we for the moment neglect the randomness in $\bar{\eta}_{it}$ and $\bar{\mu}_{it}$, equation (5) has the implication that the capital elasticity will be high, when the labor elasticity is low, and *vice versa.* This is quite sensible as a low labor elasticity could reflect shortage of capital, i.e. a situation with a high capital elasticity.

Applying (5) for the non-capital inputs and (7), it follows that (1) can be rewritten

$$\hat{q}_{it} = \hat{a}_{it} + \sum_{j \neq K} (\mu_{it}\bar{s}_{it}^{j} + e_{it}^{j})(\hat{x}_{it}^{j} - \hat{x}_{it}^{K}) + \eta_{it}\hat{x}_{it}^{K} \tag{8}$$

To summarize; only mild regularity conditions are imposed on the production technology. The model is consistent with non-constant returns to scale and the presence of imperfect competition in the sense that price can exceed marginal costs. The model allows for the possibility that capital is not fully adjusted to its equilibrium value, but is considered (quasi-) fixed while the firm solves its short run profit maximizing problem. η_{it} and μ_{it} have the interpretation of the scale elasticity and the ratio of price to marginal costs.

[16]See Morisson (1986) for an extensive discussion of the issue of capacity utilization in a related context. She considers an alternative approach, that is applicable also in the presence of several quasi-fixed factors.

3 The data

The applied sample covers almost all manufacturing industries for the period 1980-90[17]. The sample was constructed from the "Time Series"-files for Norwegian manufacturing establishments[18]. These files are based on the annual census carried out by Statistics Norway[19]. Separate analyses have been carried out for 14 different industry groups corresponding to 2/3-digit ISIC classes.

In the current study, only operating establishments with at least five employees have been included. All observations that did not report the variables required have been eliminated. I also removed observations with an extreme value added per unit of labor input or extreme value added per unit of capital. Extreme values were defined as outside a 300 percent interval of the median values for each year and each 5-digit industry. Establishments that existed for less than three consecutive years were eliminated.

Output and inputs are measured relative to the average values for the industry (at the 5-digit ISIC-code level) to which the firm belongs. The industry mean values are estimated separately for each year. This approach has two benefits. First, it eliminates the need for deflating the nominal variables. Deflators for inputs and outputs in many, if not most, manufacturing industries are heavily contaminated by noise due to the problems of dealing with goods undergoing important quality changes over time[20]. Second, by estimating the shares separately for each year and by using narrow industries we obtain a close approximation to the variables in the theoretical model that are derived on the basis of generalized mean value theorem.

Measuring the variables relative to industry time-means eliminates the role of time dummies. Consequently, the models presented below do not contain time-dummies.

Four inputs are treated separately in this study: Capital, energy, labor and materials. Details on the construction of the labor and capital variables are presented in appendix A. All costs and revenues are adjusted for taxes and subsidies, so that they should reflect the firm's revenues and expenditures[21]. Revenues are measured net of sales taxes and subsidies, and the wage payments

[17] I have left out the sector "Manufacture of food, beverages and tobacco" (ISIC 31), partly since it is very large, with almost 50 000 observations for the period considered, and partly because it is heavily regulated, questioning the validity of the behavioral model applied above. The industry "Other manufacturing" (ISIC 39) has also been eliminated as it is a rather small and heterogeneous collection of plants.

[18] See Halvorsen et al. (1991) for documentation.

[19] Statistics Norway (several years) reports a variety of summary statistics.

[20] The cost side of not (explicitly) deflating by using price deflators, is that one can not obtain estimates of technical change from the constant term or the time dummies.

[21] See Statistics Norway (several years) and Halvorsen et al. (1991) for details about these adjustments.

incorporate salaries and wages in cash and kind, social security and other costs incurred by the employer. The capital variable is constructed on the basis of fire insurance values for buildings and machinery[22]. Table 1 reports summary statistics for each industry in the sample for 1985.

4 The econometric issues

Constructing the shares

The theoretical model presented in the previous section included the factor costs' share in total revenue, evaluated at some internal point in the domain between the point of expansion (the time-industry median values) and the observed point of operation for the establishment in question. Since I do not know the location of this particular point (or the corresponding shares), I have approximated the shares by taking the mean value of the share for the observed establishments and the time-industry median share. This is only an approximation[23], and consequently an errors-in-variable problem is introduced by this construction.

In contrast to simple and extensively used production models, the framework presented in this paper is consistent with the widely recognized pattern that different firms within an industry face different wages. In particular, larger firms tend to pay higher wages and hire more high-skilled workers[24]. The model presented here captures these phenomena in two ways: (i) The fixed effects will capture differences in productivity levels between firms due to (permanent) differences in labor quality. (ii) By using the factor shares of individual establishments, as described above, the model is also consistent with variations in the marginal product of labor (and the other factors of production) across observations[25].

[22]This help us to overcome the criticism to scale estimates based on accounting measures of capital, raised by Friedman (1955). Friedman argued that accounting measures of capital would imply constant return by definition. See Griliches and Ringstad (1971, ch. 3.3 and p.59) for further remarks on the *pros* and *cons* of the use of fire insurance values to construct the capital variable.

[23]In fact, the "Quadratic approximation lemma" in Diewert (1976) shows that using the average cost share of factor j to replace $\bar{\alpha}^j_{it}$ in (1) will introduce no approximation error if the underlying technology is of the translog type. However, even if the underlying technology happened to be translog, an errors-in-variables problem will remain because of the "optimization error".

[24]See e.g. Brown and Medoff (1989) for an empirical analysis of the employer size-wage relationship.

[25]The most common panel data model of production seems to be the Cobb-Douglas specification with fixed effects. A Cobb-Douglas model with fixed effect is consistent with (i), but not (ii). The attractive aspect of the model put forward in this paper, is that it is more flexible than the Cobb-Douglas model, but has still fewer (or at least no more) parameters to be estimated.

Fixed effects

It is well known that productivity differences between firms tend to be highly persistent over time. Hence, the term $\hat{a}_{it}$ will be represented by an error component structure; $\hat{a}_{it} = a_i + u_{it}$, where a_i is treated as a fixed (correlated) effect, while u_{it} is a random error term. Notice that technical change common across plants within an industry is captured by measuring all variables as deviations from time-industry averages. Initial tests for the presence of fixed versus random (uncorrelated) effects strongly rejected the hypothesis of random effects, as is widely experienced with these kinds of data[26]. There can be several explanations for the presence of fixed effects as captured by a_i. Firms might differ in the effectiveness of the management, labor quality, the vintage of the capital and so fourth. Such differences will emerge as variations in productivity. More to the point, these productivity differences will tend to be correlated with the firm size, in the sense that more productive firms will gain larger market shares. Another possible explanation for fixed effects, is that some establishments do not have their own headquarter activities, while others do. This will show up in measured productivity. Furthermore, if there is a correlation between establishment size and the frequency of establishments incorporating their own headquarter services, the estimates will be inconsistent unless fixed (correlated) effects are incorporated into the estimated model. Whatever the reason, the model and the data require a fixed effect formulation. To eliminate the fixed effect, the model is estimated in terms of first differences.

The orthogonality conditions and GMM-estimation

The estimating equation is

$$\Delta\hat{q}_{it} = \mu\Delta\hat{x}_{it}^{V} + \eta\Delta\hat{x}_{it}^{K} + \Delta v_{it}, \tag{9}$$

where I have defined the variable $\hat{x}_{it}^{V} = \sum_{j \neq K} \bar{s}_{it}^{j}(\hat{x}_{it}^{j} - \hat{x}_{it}^{K})$. Δv_{it} is given as $v_{it} - v_{it-1}$, where

$$\begin{aligned} v_{it} &= u_{it} + \sum_{j \neq K} e_{it}^{j}(\hat{x}_{it}^{j} - \hat{x}_{it}^{K}) \\ &\quad +(\mu_{it} - \mu)\hat{x}_{it}^{V} + (\eta_{it} - \eta)\hat{x}_{it}^{K} \end{aligned} \tag{10}$$

[26]Cf. e.g. Hsiao (1986, ch. 3) for a discussion of fixed effects versus alternative specifications for panel data models. Hsiao (1986, ch. 3.5) outlines the Hausman test for fixed effects, that has been applied in the preliminary stage of the present study.

Equation (9) can not be consistently estimated by OLS. First, the "optimization errors" (e_{it}^{j}) introduce a correlation between the error term and the first regressor. Second, there might be a correlation between the productivity term and the choice of factor inputs. Allowing for the fixed effects, and estimating the model in growth rates, will to a large extent remove this problem, as discussed above. However, this method might not solve the whole correlation problem. To the extent that a firm experiences *changes* in productivity over time relative to the average firm, a productivity shock might be "transmitted" to inputs to the extent that the shock is anticipated before the inputs are determined[27]. This will create a correlation between the right hand side variables and the error term in (9). Lastly, errors-in-variables due to reporting errors will create an endogeneity problem. The errors-in-variables problem is well known to be augmented when estimating the model in first differences (see e.g. Griliches, 1986).

The model has been estimated using orthogonality assumptions between v_{it} and alternative sets of instruments:

$$E(v_{it}Z_{is}) = 0, \tag{11}$$

where Z_{is} is a vector of instruments dated s.

Two steps have been taken to ensure that the instrument set is chosen so that the condition (11) is fulfilled. First, the instrument set has been restricted to two variables: the capital variable and the number of employees. These variables are less responsive than the inputs materials, energy and manhours, to temporary changes in productivity[28]; see Biørn and Klette (1994) for some econometric support to this claim. Second, within this set of instruments, alternative orthogonality assumptions have been tested. I have tested the assumptions whether the instruments are strictly exogenous, predetermined or (only) contemporaneously correlated with the errors. That is to say, I have tested whether the condition (11) hold for:

(I) All values of t and s.

(II) Only for non-contemporaneous instruments, i.e. $|t - s| \geq 1$. Such an instruments set is interesting when the error term in (9) is not autocorrelated beyond an MA(1) structure[29].

[27]The term "transmitted" is borrowed from the old production function literature which examined the case for a "fixed effect". Cf. Zellner et al. (1966) and Mundlak and Hoch (1965).

[28]Lagged values of $\hat{x}_{it}^{V}$ could also been considered as instruments, but on the basis of results reported in Klette (1993) I found that this did not significantly improve my estimates.

[29]Griliches and Hausman (1986), Hayashi and Inoue (1992), and Biørn and Klette (1994) have discussed and

(III)-(V) Only predetermined instruments, i.e. $t - s \geq l$, for three different values of l; l = 0,1 or 2.

There are five alternative specification of the orthogonality conditions. The procedure I have used to test between these specifications will be discussed below.

It is standard practice in the random coefficient literature, to assume that $(\mu_{it} - \mu)$ and $(\eta_{it} - \eta)$ are independently distributed (from the regressors), mean zero random variables[30]. This assumption is sufficient to ensure that the two last terms in v_{it} (cf. (10)) do not violate the orthogonality conditions (11), and thereby create problems of inconsistency. But independence between the random components of the coefficients and the explanatory variables as well as the instruments, is a too strong assumption to be comforting in the present context. Furthermore, this assumption is not needed. What we need for consistent (IV-) estimation is the assumption that

$$E[(\mu_{it} - \mu)\hat{x}_{it}^V Z_{is}^j] = 0 \qquad \forall j, \tag{12}$$

and similarly for the term involving $(\eta_{it} - \eta)$. Z_{is}^j is the jth component of the instrument vector. The point is that (12) involves a *centered third order moment*[31], that will be zero if these variables have a multivariate normal distribution. That is, we can replace the assumption of independently distributed parameters by the assumption that $\mu_{it}, \hat{x}_{it}$ and Z_{is} have a joint normal distribution. In the current context this is highly desirable, as one might expect that there is a systematic relationship between firm size (cf. capital and the number of employees in the instrument vector Z_{it}) and the markup or the scale elasticity. It is essential that the variables are centered for the claim to hold. In our case, all variables are centered as they are measured as deviations from time-industry average values.

GMM (Hansen, 1982) provides the optimal way to combine the set of orthogonality conditions (11). The GMM estimator $(\hat{\mu}, \hat{\eta})$ minimizes

$$J = N\left[\frac{(\Delta v)'Z}{N}\,\hat{V}^{-1}\,\frac{Z'\Delta v}{N}\right], \tag{13}$$

applied similar instrument sets.

[30]See Judge et al. (1985, ch. 13.5) for a discussion and references to the literature.

[31]Recall that all variables, including the instruments, are measured as deviations from time-industry average values.

where I have stacked all the Δv_{it}'s in (9) into a single vector Δv, and Z is a matrix with all the instruments[32]. N is the total number of observations. $\hat{V}$ is a consistent estimator of the covariance matrix of $(Z'\Delta v)$.

Some additional remarks on the choice of IVs

Both Hall and the present study apply an instrumental variable approach to the estimation of the markups and other parameters of interest. Hall pointed out the need for instruments due to the possible transmission of productivity shocks to factor demand, as discussed in the previous section. This potential "transmission bias"[33] motivated the choice of the number of employees and capital as instruments in the present study. Let me emphasize that the instrument set used here is entirely different from Hall's instrument set. Hall used the oil price, military spending and a dummy for the party of the president as his three instruments. Abbott et al. (1988) have argued forcefully that the oil price is not a valid instrument; see below. Estimation by lagged values of the instruments, as I have done, should further reduce the problem of transmission bias. Notice that the "transmission bias", if present, is likely to bias the parameter-estimates *upward*, since positive productivity shocks will typically stimulate investment and hiring.

Abbott et al. (1988) has shown that the instrumental variable estimates reported by Hall are in fact higher than the OLS estimates obtained from the same sample. Abbott et al. argue that this is because Hall's instruments are not valid, and that the IV-estimates are upward biased. A different explanation is implicit in the discussion presented in the previous section. That is, inferring the output elasticity of each of the variable inputs from the cost shares provides only an approximation and introduces an "errors-in-variable" problem. Other variables in the data are most likely also contaminated with noise. The "errors-in-variable" problem creates a *downward* bias in the OLS estimate[34], that is (partly) removed by applying an instrumental variable technique.

Abbott et al. emphasize the omission of adjustment for capacity utilization in the models estimated by Hall[35]. Their point is that this omitted variable problem creates biases since

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[32]The care needed in stacking the instrument vector in the presence of an unbalanced set of panel data has been discussed by Arellano and Bond (1988, 1991). See also Biørn and Klette (1994). The GMM-estimates presented in the current study have been obtained using the GAUSS-program "DPD" documented in Arrelano and Bond (1988).

[33]See Mundlak and Hoch (1965) for an extensive discussion on this topic for panel data.

[34]Cf. e.g. Griliches (1986, p. 1478) for a discussion.

[35]See also Eden and Griliches (1993) for a related discussion.

Hall's instruments are correlated with a left out variable: the degree of capacity utilization. But keep in mind that Hall adjusts for changes in capacity utilization of capital by using a residual share to impute the output elasticity of capital. However, his procedure is only correct to the extent that constant returns to scale is a valid maintained hypothesis. In the present study, the constant returns to scale hypothesis is rejected in most industries and relaxing this hypothesis significantly reduces the markup estimates. Both Hall and the present study use manhours as the measure of labor inputs, which should to a certain extent reduce the need to adjust for changes in utilization of the work force[36]. In the estimates that are based on lagged instruments, the biases from omitted adjustment for capacity utilization should be further reduced.

Specification testing

As shown by Hansen (1982), the minimized value of J in (13) has asymptotically a Chi-square distribution with degrees of freedom given as the number of orthogonality conditions minus the number of parameters. I have used this J-statistic to test the validity of the various specifications discussed above. Only models with sufficiently low J-values have been considered as acceptable. Newey (1985) has pointed out that even though the J-statistic comes closest to be an omnibus test for misspecification for models estimated by GMM, it has some limitations. He shows how the J-statistic may fail to detect misspecified models. A more focused specification test, that considers a specific subset of *a priori* suspect instruments, is desirable. As pointed out by Arellano and Bond (1991), this can easily be done for nested hypotheses on the basis of the J-statistics. Denote the J-statistic for the extended instrument set by J_E, and consider a subset of instruments, with J-statistic J_M, that is considered valid under the maintained hypothesis. In that case, $J_E - J_M$ has a Chi-square distribution with degrees of freedom given by the difference in the number of orthogonality conditions between the two sets of instruments (see Arrelano and Bond (1991) for a formal derivation of this result). I will refer to such a test as a J-difference test.

The test scheme between the alternative sets of orthogonality conditions are presented in figure 1. The procedure has been as follows: I have started at the top, with model V. If that specification is accepted on the basis of its J-statistic, the next model (with additional orthogonality conditions) has been considered; see model IV (neglect model II for the moment).

[36] See Hall (1990) for a detailed discussion of different kinds of misspecification related to this point.

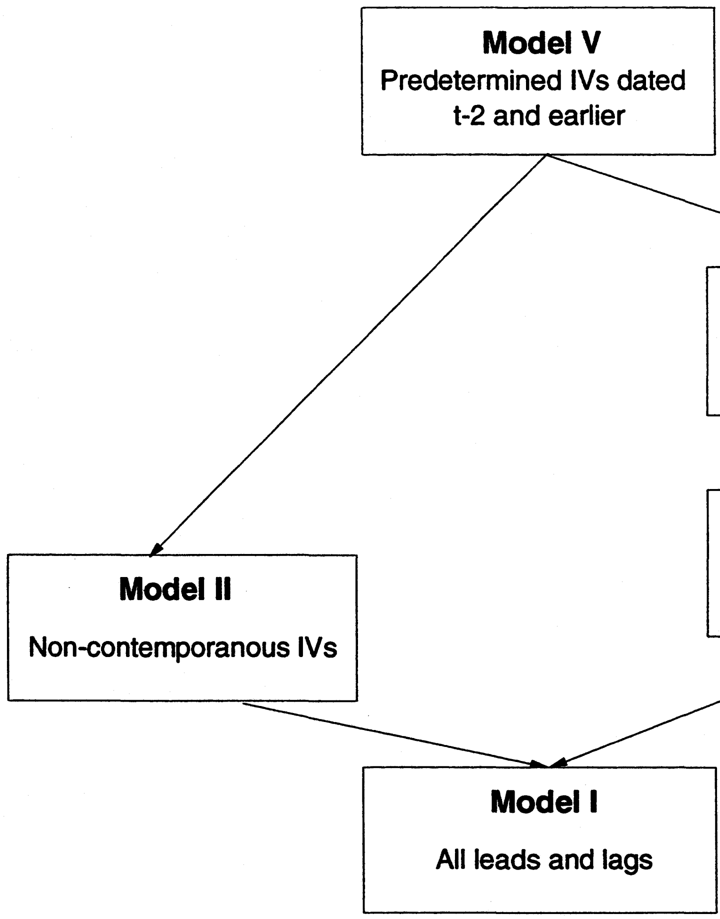

Figure 1: *Specification testing for the choice of instruments. The model furthest down in the figure, which is not rejected by the specification test, is the preferred specification.*

That next model has been preferred if it does not fail on the basis of its J-statistic, or on the basis of the J-difference test for the two models.

As shown in figure 1, model I corresponds to using all leads and lags (of capital and the number of employees) as instruments. Model II uses only non-contemporaneous instruments, i.e. when instrumenting for growth rates from t-1 to t, only variables dated t-2 and earlier and t+1 and later are used as instruments. Model III restricts the instrument set only to predetermined variables, dated t and earlier, while model IV and V restrict the instrument sets to respectively t-1 and t-2 and earlier.

There is one problem with this procedure. An instrument set based on predetermined variables dated, say, $t-1$ and earlier (see model IV in fig. 1) does not nest the instrument set based on non-contemporaneous variables (model II in fig. 1). There is no clear cut answer to which model to prefer when two such models are competing. In the present case, the estimates based on the non-contemporaneous instruments will be reported in the tables, but I will also discuss the estimates of the alternative specification in the text.

5 Results

Specification testing

The results from the specification tests are presented in table 2. The first 5 rows present the overidentification tests (the J-values) for each instrument set separately. Rows 6-10 in table 2 present the outcomes of the J-difference tests.

None of the instrument sets are rejected for the industries with ISIC-codes 321, 332, 341, 351-2, 36, 37, 383 and 384. I have consequently chosen the most extensive instrument set, I, as the preferred specification for these industries. For the industries 322-4, 331 and 381, the instrument set II has been chosen. For the industries 331 and 381 both instrument sets III and IV are rejected on the basis of the overidentification tests. Instrument set III is rejected on the basis of the J-difference test for the industry 322-4. I will present the results based on instrument set II for this industry, but comment also on the results based on instrument set IV[37]. For the industries 355-6 and 382 the instrument sets III and IV, respectively, are preferred. None of the instrument sets have been accepted for industry 342. As we shall see below, this industry stands out in several respects[38]. A more detailed investigation of this industry is left for future research.

Basic results

Table 3 shows that a clear majority of the industries considered in this study reveal significant market power. Ordered according to declining market power, the industries are: Metals (37), Wood products (331), Paper products (341), Mineral products (36)[39] , Clothing (322-4), Metal

[37]Cf. the discussion on the choice of non-nested specifications above. For the three industries - 322-4, 331 and 381 - the instrument set I has not been rejected in a direct test against II. But the instrument set III, which is strictly larger than I, has been rejected. Hence, the instrument set I should also be rejected.

[38]A number of experiments, such as splitting it up into finer industry categories and restricting the instrument set further, have been run on this industry without success. However, the results were poorest for the subindustry group "Printing and bookbinding" (ISIC 3421).

[39]The alternative choice of instruments, based on predetermined instruments dated $t-2$ and earlier, provided an estimated price-cost margin at 1.137 (std.err: 0.032) and a scale elasticity at 0.963 (std.err: 0.026).

products (381)[40], Electrical equipment (383), Plastics (355-6), Furniture (332), Textiles (321), Machinery (382) and Transport equipment (384). The margins between price and marginal costs for these industries range from 1.10 for Metals to 1.04 for Transport equipment. Only one industry, Chemicals (351-2), exhibits a perfectly competitive price-cost relationship[41].

Printing (342) obtained a very low parameter estimate[42]. But this result should be neglected as the overidentification test presented above, reveals that the model is misspecified. It is comforting that the overidentification test is able to identify this industry/sample as suspect, given the implausible parameter estimates.

Turning to the scale elasticities, none of the industries reveal significant scale economies. Four industries do not reject constant returns to scale: Clothing (322-4), Paper products (341), Metals (37) and Transport equipment (384). Another 8 industries reveal moderate decreasing returns to scale (in the range 0.91-0.98): Textiles (321), Wood products (331), Furniture (332), Plastics (355-6), Mineral products (36), Metal products (381), Machinery (382) and Electrical equipment (383). The scale elasticities are very low for two industries: Chemicals (351-2) and Printing (342). The results for Printing should be ignored, as discussed above. The scale estimate for the Chemical industry should also be considered with some caution, given the low parameter estimate for the price-cost margin.

A comparison to related results

There are not many recent publications addressing the question of scale economies and/or markups in Norwegian manufacturing. Griliches and Ringstad (1971) used a cross section of establishments from 1963 to estimate scale economies in Norwegian manufacturing. They found scale economies around 1.05-1.06 for total manufacturing and mining[43]. The results in Griliches

[40]Choosing instruments based on observations dated $t-1$ and earlier, provided an estimated price-cost margin at 1.005 (std.err: 0.012) and a scale elasticity at 0.930 (std.err: 0.010).

[41]In fact, this industry obtained an estimate of the markup significantly below one in purely statistical terms. However, the precision of the estimate, as indicated by the (heteroskedasticity-robust) standard error, is suspiciously high. I believe that the reported standard error exaggerates the precision of this 2-step GMM-estimate, as has been suggested by the Monte-Carlo studies of Arrelano and Bond (1991). The 1-step GMM-estimate is 0.97 with a robust standard error equal to 0.05, which clearly accepts the hypothesis of "price equal to marginal costs". In any case, the difference between the markup estimate and one (the competitive case) is close to negligible in substantial (economic) terms.

[42]The estimates are implausible and very similar for all the alternative instrument sets (I-V).

[43]See Griliches and Ringstad (1971), tables 4.14 and B.7. Ringstad (1978) repeated these regressions on the corresponding 1974 Census data, with very similar results. Ringstad (1971) also examined scale economies by means of a set of panel data, covering large firms in Norwegian mining and manufacturing for the period 1959-67. In his covariance analysis, he found substantial decreasing returns in most of the industries considered. Ringstad

and Ringstad (1971) and Ringstad (1978) differ substantially from the findings presented in this paper, as I do not find any presence of increasing returns. Since the study of Griliches and Ringstad, it has become a widely held view that scale estimates from cross sectional studies are upward biased, as they do not account for persistent differences in efficiency between plants[44].

The work of Hall (1988, 1990) suggested very high price cost margins and scale economies in U.S. manufacturing, using a similar methodology as presented here. However, Hall's result has been criticized by Norrbin (1993), who finds that when material inputs are adequately incorporated into the model, the price-cost margins are very small[45].

6 Heterogeneity in the parameters

As the industry categories considered in this study are fairly broad, it is interesting to examine whether there are large variations in scale economies and price-cost margins *within* these categories. If we are willing to impose a few additional assumptions, this can be done by using a method suggested in the literature on the random coefficient model; see Mairesse and Griliches (1990) and references cited there. Consider the residuals

$$\begin{aligned}\nu_{it} &\equiv \hat{q}_{it} - \hat{\mu}\hat{x}^V_{it} - \hat{\eta}\hat{x}^K_{it} \\ &= \hat{a}_{it} + \hat{v}_{it} \\ &= a_i + (\mu_i - \mu)\hat{x}^V_{it} + (\eta_i - \eta)\hat{x}^K_{it} + \omega_{it}.\end{aligned} \tag{14}$$

ω_{it} captures sampling error and the annual fluctuations in the coefficients. Let us now assume that ω_{it} is uncorrelated with $\hat{x}_{is}$, when $|t-s| > l$, for some value of l (=1,2,3..). Then, it is easy to show that

$$\begin{aligned}E(\nu_{it}\nu_{is}|\hat{x}^V_{it}, \hat{x}^K_{it}, \hat{x}^V_{is}, \hat{x}^K_{is}) = \sigma^2_a + \sigma^2_\mu \hat{x}^V_{it}\hat{x}^V_{is} + \sigma^2_\eta \hat{x}^K_{it}\hat{x}^K_{is} + \sigma^2_{a\mu}(\hat{x}^V_{it} + \hat{x}^V_{is}) \\ +\sigma^2_{a\eta}(\hat{x}^K_{it} + \hat{x}^K_{is}) + \sigma^2_{\mu\eta}(\hat{x}^V_{it}\hat{x}^K_{is} + \hat{x}^K_{it}\hat{x}^V_{is}) \qquad |t-s| > l,\end{aligned} \tag{15}$$

concluded that his results were not reliable, due to measurement errors in his labor and capital variables.

[44] See the references in footnote 9.

[45] Norrbin argues that the previous analysis by Domowitz et al. (1988), which accounted for material inputs in Hall's model, was based on inadequate data. Domowitz et al. found results which confirmed Hall's conclusion about substantial market power in U.S. manufacturing.

where σ_a^2 is the variance of the a_i's, that is, the variance of the permanent productivity differences between plants. σ_μ^2 and σ_η^2 are the variances of the price-cost-margins and the scale elasticities; $\sigma_{a\mu}^2$, $\sigma_{a\eta}^2$ and $\sigma_{\mu\eta}^2$ represent the covariances between the differences in productivity, the price-cost margins and the scale elasticities.

The variances have been estimated by regressing cross-products of the residual term on the $\hat{x}_{it}$'s and their squares and cross-products. There are many possible choices of t and s; the most efficient estimates of the σ^2s are obtained by pooling the estimates by combining all permissible combinations. Table 4 reports the outcome of such an estimation procedure[46]. It turned out that the estimated covariances were insensitive to the choice of l in (15), and all the estimates in table 4 are based on l=1.

The results in table 4 reveal significant differences in (permanent) productivity levels (cf. the fixed effects) across plants within all industries except one. The largest variance appears in Paper products (341), with $\sigma_a^2 = 0.043$, and the smallest in Plastics, with $\sigma_a^2 = 0.001$ (not significantly different from zero). The weighted average of these variances across industries is 0.013, using the inverse of the standard errors as weights. I will neglect the Printing industry (342) from the analysis in this section, as the estimated model is clearly misspecified for this industry.

The variation in price-cost-margins is largest in Plastics (355-6) and smallest in Textiles (321) and Paper products (341). The average value of these variances is 0.004[47]. This is 4 times the variance of the markups (across industries) presented in table 3. Turning to the scale elasticities, the largest variance is in Plastics (355-6) and the smallest is in Metal products (381). The weighted average variance is 0.003, which is 3 times as large as the variance of the scale elasticities (across industries) presented in table 3. In this sense, there are larger differences in these coefficients within the industry categories, as compared to between industries. It is interesting that the variances of the productivity differences (cf. σ_a^2) and the scale elasticities (or the markups) are between one and two order of magnitudes smaller than the coefficient variances found by Mairesse and Griliches (1990, see in particular table 6).

Table 4 shows that firms with higher productivity tend to set *lower* markups, as can be seen from the negative values of $\sigma_{a\mu}$. This is a bit surprising as one might expect that more productive

[46]The heteroskedasticity-robust standard errors reported in the table allow for correlation in the residuals as I am combining various ts and ss for each plant.

[47]This average is based weighted with the inverse of the standard errors as weights.

firms will use their productivity advantage to charge a higher markup[48]. On the other hand, more productive firms might to a larger extent export their products to international markets, and thereby be more exposed to competition. Plants in more competitive niches of the industry might be forced to be more productive and charge a lower markup; a story also consistent with the observed negative covariance[49].

7 Concluding remarks and future research

This paper presents evidence on imperfect competition in most industries in Norwegian manufacturing. The (average) margins between price and marginal costs are statistically significant, but small in economic terms: between 5 and 10 percent. My estimates suggest quite large variances in this margin within each industry. The rather small, average margins indicate that only small welfare gains can be obtained from a more pro-competitive policy for the manufacturing sector. The estimates presented in this paper suggest that increasing returns to scale is not a widespread phenomenon in Norwegian manufacturing. Rather, the average firm in most industries seems to face moderate decreasing return to scale.

Given the large interest in non-competitive models and theories about increasing returns in the economic discipline, the results presented in this paper are perhaps somewhat surprising or disappointing. A potential explanation for the low parameter estimates presented here could be the presence of significant noise in the data. This is a common explanation for the pattern that panel data estimates with fixed effects, as presented in this paper, tend to provide low parameter estimates in general[50], and low scale elasticities when considering production functions in particular[51]. For the results presented in this paper, the errors-in-variables problem has been reduced by using instrumental variable estimation. However, this procedure might not solve the whole problem. The impact of the errors-in-variables problem has been addressed in a different manner in Willassen and Klette (1994). We find that errors-in-variables can only account for a moderate downward bias in the price cost margins and the scale elasticities (less than a 5

[48] A homogeneous product Cournot model suggests a positive relationship between productivity and markup. This positive relationship is also the standard assumption in the literature on innovation; see e.g. Dasgupta and Stiglitz (1980).

[49] Harrison (1994) has provided evidence from Cote d'Ivoire, which suggests links between trade protection, productivity and pricing behavior

[50] Griliches (1986).

[51] See e.g. Mairesse and Griliches (1991).

percent downward bias).

It is a widely observed pattern that factor demand equations give scale estimates that are substantially higher than production functions estimates, when both are estimated from (the same set of) panel data[52]. The errors-in-variables problem is also often used as the explanation for this anomaly. Biørn and Klette (1994) show that the errors-in-variables problem is not the sole explanation for the large scale coefficients often found in estimates of factor demand equations. The large discrepancy between the scale estimates from factor demand and production function is a major puzzle in (panel data) research on producer behavior, and deserves further attention.

In joint work with Zvi Griliches (Klette and Griliches, 1992), I have examined the bias in the estimation of cost- and production function models, caused by replacing real output by deflated sales, where deflation is based on an industry-wide deflator. This bias might be important in an industry with price dispersion and price-setting firms. Notice that such a deflating procedure is essentially equivalent to the normalization approach used in the present study. The point is that if idiosyncratic productivity shocks are important determinants of firm growth, growth in deflated sales will be a systematically biased indicator for growth in real output. This bias tends to create an inconsistency in estimated scale coefficients. Such an inconsistency in the scale coefficient might well be present in the estimates presented above. See Klette and Griliches (1992) for a possible solution to this problem when real output is not available.

This paper has followed standard practice and focused on scale economies without distinguishing between output changes along different margins. Alchian (1966) argued that empirical studies of scale economies should distinguish between scale economies related to the length of the production run (the total amount of output) and scale economies from changes in the output rate (given the length of the production run). The theoretical I.O.-literature seems to focus on scale economies related to the first margin, emphasizing phenomena such as setup costs and learning-by-doing. However, the empirical literature, including the present study, rarely distinguishes between output changes due to longer production runs, versus higher annual output rates. Though one might think the changes along these two margins are correlated, this is not evident: A firm might increase its annual output rate by constantly introducing new models, thereby reducing the production run for each model.

[52]This is illustrated in Klette and Griliches (1992).

Hall's estimates (Hall, 1988 and 1990) of markups and scale economies imply that traditional growth accounting and TFP-estimates, based on perfect competition and constant returns to scale, are totally misleading. The magnitude of the estimated price-cost margins and scale elasticities presented in this paper suggests that the standard assumptions in TFP-calculations may be acceptable in a number of cases, at least for Norwegian manufacturing. Still, the estimates presented here show that the standard assumptions of perfect competition and constant returns to scale, introduce a downward bias in the growth contribution from labor and material inputs in most sectors in Norwegian manufacturing. Correspondingly, there is a general upward bias in the estimate of the growth contribution of capital. More generally, one will tend to obtain an inflated estimate of the marginal product of capital based on residual calculations using the assumptions of constant returns and perfect competition. In fact, the estimates presented in this paper imply *marginal* rates of return to capital very close to zero in all industries. To what extent this finding reflects an excessive physical capital stock is an interesting topic for future research. Such an excessive capital stock could be due to the favorable tax treatment of physical investment in Norway[53], unfulfilled expectations from the 1970s[54], or perhaps to chronic excess capacity acquired for strategical reasons (see Bulow et al. (1985)).

[53]See Biørn (1989) and Holmøy et al. (1993).
[54]See Griliches (1988).

References:

Abbott, T.A., Z.Griliches and J.A.Hausman (1988): Short Run Movements in Productivity: Market Power versus Capacity Utilization. Paper presented at the NBER Summer Institute 1988.

Alchian, A. (1959): Cost and Output, in M.Abramowitz et al.: *The Allocation of Economic Resources.* Stanford University Press (Stanford, CA.).

Arellano, M. and S.R. Bond (1988): Dynamic Panel Data Estimation Using DPD - A Guide for Users. Working Paper 88/15, Institute for Fiscal Studies.

Arellano, M. and S.R. Bond (1991): Some Tests of Specification for Panel data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies* 58, 277-97.

Bartelsman, E.J, R.J. Caballero and R.K. Lyons (1991): Short and Long Run Externalities. NBER Working Paper no. 3810.

Berck, P. and K. Sydsæter (1991): *Economists' Mathematical Manual.* Springer-Verlag (Heidelberg).

Biørn, E. (1989): *Taxation, Technology and the User Cost of Capital.* North Holland Publ. Co. (Amsterdam).

Biørn, E. and T.J. Klette (1994): Errors in Variables and Panel Data: The Labour Demand Response to Permanent Changes in Output. Discussion Papers 125, Statistics Norway.

Bresnahan, T.F. (1989): Empirical Studies of Industries with Market Power, in *Handbook of Industrial Organization, Vol. 2*, R. Schmalensee and R. Willig (eds.), North Holland Publ. Co.

Brown, C. and J. Medoff (1989): The Employer Size-Wage Effect. *Journal of Political Economy* 97, 1027-59.

Bulow,J.I., J.D.Geanakoplos and P.D.Klemperer (1985): Holding Idle Capacity to Deter Entry. *Economic Journal* 93, 178-82.

Chamberlain, G. (1982): Multivariate Regression Models for Panel Data. *Journal of Econometrics* 18, 5-46.

Chirinko, R.S. and S.M. Fazzari (1994): Economic Fluctuations, Market Power, and Returns to Scale: Evidence from Firm-Level Data Journal of Applied Econometrics 9, 47-69.

Demsetz, H. (1973): Industry Structure, Market Rivalry, and Public Policy. *Journal of Law and Economics* 16, 1-10.

Diewert, E. (1976): Exact and Superlative Index Numbers. *Journal of Econometrics* 4, 115-45.

Domowitz,I., R.G.Hubbard and B.C.Petersen (1988): Market Structure and Cyclical Fluctuations in U.S. Manufacturing. *Review of Economics and Statistics* 70, 55-66.

Eden, B. and Z. Griliches (1993): Productivity, Market Power and Capacity Utilization when Spot Markets Are Complete. *American Economic Review, Papers and Proceedings* 83, 219-23.

Friedman, M. (1955): Comment, in C.A. Smith (ed.): *Business Concentration and Price Policy. A report of the National Bureau of Economic Research.* Princeton University Press (Princeton).

Griliches, Z. (1986): Economic Data Issues. in Z. Griliches and M.D. Intriligator: *Handbook of Econometrics, Vol. 3.* North-Holland Publ.Co. (Amsterdam).

Griliches, Z. (1988): Productivity Puzzles and R&D: Another Nonexplanation. *Journal of Economic Perspectives 2*, 9-21.

Griliches, Z. and J.A.Hausman (1986): Errors in Variables in Panel Data Journal of Econometrics 18, 93-118.

Griliches, Z. and V. Ringstad (1971): *Economies of Scale and the Form of the Production Function.* North-Holland Publ.Co. (Amsterdam).

Hall, R.E. (1988): The Relationship between Price and Marginal Cost in U.S. Industry. *Journal of Political Economy* 96, 921-47.

Hall, R.E. (1990): Invariance Properties of Solow's Productivity Residual. in P. Diamond (ed): *Growth, Productivity, Unemployment.* MIT Press (Cambridge, US.).

Halvorsen,R., R.Jensen and F.Foyn (1991): Dokumentasjon av Industristatistikkens Tidsseriebase ("Documentation of the Panel Data Base for Manufacturing"). Mimeo, Statistics Norway (In Norwegian).

Hansen, L.P. (1982): Large Sample Properties of a Generalized Methods of Moments. *Econometrica* 50, 1029-54.

Harrison, A.E. (1994): Productivity, Imperfect Competition and Trade Reform: Theory and Evidence. *Journal of International Economics* 36, 53-74.

Hayashi, F. and T. Inoue (1991): The Relation between Firm Growth and Q with multiple Capital Goods: Theory and Evidence from Panel Data on Japanese Firms. *Econometrica* 59, 731-54.

Holmøy,E., B.M.Larsen and H.Vennemo (1993): *Historiske Brukerpriser på Realkapital.* Reports 93/9, Statistics Norway.

Hsiao, C. (1986): *Analysis of Panel Data.* Cambridge University Press (Cambridge, U.K.).

Judge, G.G. et al. (1985): *The Theory and Practice of Econometrics, Second Edition.* John Wiley and Sons (New York).

Klein, L.R. (1953): *A Textbook of Econometrics.* Row, Peterson and Company (Evanston, Ill.).

Klette, T.J. (1993): Is Price Equal to Marginal Costs? An Integrated Study of Price Cost Margins and Scale Economies among Norwegian Manufacturing Establishments 1975-90. Discussion Paper no. 93, Statistics Norway.

Klette, T.J. (1994): R&D, Scope Economies and Company Structure: A "Not-so-Fixed Effect" Model of Plant Performance. Discussion Papers 120, Statistics Norway.

Klette, T.J. and Z. Griliches (1992): The Inconsistency of Common Scale Estimators when Output Prices are Unobserved and Endogenous. NBER Working Paper No. 4026.

Levinsohn, J. (1993): Testing the Import-as-Market-Discipline Hypothesis. *Journal of International Economics* 35, 1-22.

Lucas, R.E. (1978): On the Size-Distribution of Firms. *Bell Journal of Economics* 9, 508-23.

Mairesse, J. (1990): Time-series and Cross-sectional Estimates on Panel Data: Why Are They Different and Why Should They Be Equal?. in J.Hartog, G.Ridder and J.Theeuwes (eds.): *Panel Data and Labour Market Studies.* North Holland Publ. Co. (Amsterdam).

Mairesse, J. and Z.Griliches (1990): Heterogeneity in Panel Data: Are There Stable Production Functions?. in P. Champsaur et al. (eds.): *Essays in Honour of Edmond Malinvaud, Vol. 3: Empirical Economics.* MIT Press.

Marschak, J. and W. Andrews (1944): Random Simultaneous Equations and the Theory of Production. *Econometrica* 12, 143-205,.

Morrison, C.J. (1986): Productivity Measurement with Non-Static Expectations and Varying Capacity Utilization Journal of Econometrics 33, 51-74.

Mundlak, Y. (1978): On the Pooling of Time-Series and Cross-section Data. *Econometrica* 46, 49-85.

Mundlak, Y. and I. Hoch (1965): Consequences of Alternative Specifications of Cobb-Douglas Production Functions. *Econometrica* 33, 814-28.

Newey, W.K. (1985): Generalized Methods of Moments Specification Testing Journal of Econometrics 29, 229-56.

Nickell, S., S. Wadhwani and M. Wall (1991): Productivity Growth in UK Companies, 1975-86. CEPR Discussion Paper no. 26.

Norrbin, S.C. (1993): The Relation between Price and Marginal Cost in U.S. Industry: A Contradiction Journal of Political Economy 101, 1149-64.

Panzar, J.C. (1989): Technological Determinants of Firm and Industry Structure. in R. Schmalensee and R. Willig (eds.): *Handbook of Industrial Organization, Vol. 1*, North Holland Publ. Co. (Amsterdam).

Ringstad, V. (1971): *Estimating Production Functions and Technical Change from Micro Data.* Social and Economic Studies 21, Statistics Norway (Oslo).

Ringstad, V. (1978): Economies of Scale and the Form of the Production Function. Some New Estimates. *Scandinavian Journal of Economics* 80, 251-64.

Statistics Norway (several years): *Manufacturing Statistics.* Official Statistics of Norway NOS C 36.

Simpson, M.J. (1994): Foreign Control and Norwegian Manufacturing Performance Discussion Papers 111, Statistics Norway.

Thomas, G.B. (1968): *Calculus and Analytic Geometry.* Addison Wesley Publ. Co. (Reading, Mass.) .

Varian, H.R. (1992): *Microeconomic Analysis, 3rd edition.* W.W Norton & Co (New York).

Willassen, Y. and T.J. Klette (1994): Correlated Measurement Errors, Bounds on Parameters and a Model of Producer Behavior. Discussion Papers 112, Statistics Norway.

Zellner, A., J.Kmenta and J.Dreze (1966): Specification and Estimation of Cobb-Douglas Production Functions. *Econometrica* 34, 784-95.

Appendix A: Details on the construction of the labor and capital variables

This appendix presents details about the construction of the labor and capital input variables used in the present study.

Before 1982, manhours referred to blue collar workers only. Following Griliches and Ringstad (1971, p.24), total labor input (X_{it}^L) was estimated according to the formula

$$X_{it}^L = H_{it}\left(1 + \frac{C_{it}^{wc}}{C_{it}^{bc}}\right), \tag{16}$$

where H_{it} is manhours for blue collar workers. C_{it}^{wc} and C_{it}^{bc} refer to total wage costs for white collar and blue collar workers. After 1982, the total number of manhours was reported (while manhours for blue collar workers alone were not), and used as the labor input variable.

As in most studies, capital inputs are perhaps the most problematic of the variables used in my analysis. My sample has an advantage to most other production data sets, in that the establishments report total fire insurance values for machinery and buildings (separately). Rental costs for rented capital are also reported. One of the problems with the fire insurance values is that there are a lot of missing values. Also, these variables have not been used by Statistics Norway, and little effort has been spent identifying and correcting erroneous reports. Once more, I have followed Griliches and Ringstad (1971, p.27) and estimated the capital services as

$$X_{it}^K = R_{it} + (\rho + \delta^M)V_{it}^M + (\rho + \delta^B)V_{it}^B \tag{17}$$

where R_{it} is rental costs, ρ is a real rate of return, and δ^M and δ^B are depreciation rates for machinery and buildings. ρ is chosen as the average real rate of return to physical capital in manufacturing (0.07), and the depreciation rates are taken from the Norwegian National Accounts (0.06 and 0.02 for machinery and buildings, respectively). V_{it}^M and V_{it}^B are the fire insurance values for machinery and buildings at the beginning of the year. ρ, δ^M and δ^B are to be considered as rough weights. Clearly, this procedure is a rough weighting of the different components of capital, and the validity of these weights varies substantially across plants and years. An interesting topic for future work would be to estimate the weights as an integrated part of the econometric modeling.

To avoid losing too many observations due to missing fire insurance values, and to eliminate some noise, three different estimates of the fire insurance value were calculated for each observation (plant-year). In addition to the reported fire insurance values for year t, the fire insurance values were also estimated by a perpetual inventory method on the basis of investment figures and fire insurance values for the years t+1, t and t-1 (if available). The mean value of the three different estimates was used as the final estimate.

Table 1: Summary statistics for the year 1985

Industry (ISIC - code)	Sales[1]		Workers		Value added per worker[2]		Capital per worker[2]		Residual share		Plants	Firms
	Mean	Std.dev.	Mean	Std.dev	Mean	Std.dev.	Mean	Std.dev	Mean	Std.dev		
Textiles (321)	14.1	19.3	37.5	47.0	1.43	0.59	0.56	0.42	0.11	0.10	208	186
Chlothing (322-4)	8.8	13.4	29.8	33.9	1.30	1.10	0.26	0.24	0.10	0.12	183	175
Wood products (331)	13.7	27.8	23.7	44.1	1.73	0.74	0.47	0.44	0.12	0.10	738	686
Furniture (332)	16.3	35.5	32.5	53.7	1.69	0.58	0.42	0.21	0.12	0.08	241	233
Paper (341)	120.9	196.5	120.9	156.5	2.39	1.73	1.65	1.37	0.09	0.09	108	76
Printing (342)	17.5	56.0	37.8	14.5	2.45	1.35	0.55	0.45	0.15	0.15	772	752
Chemicals (351-2)	116.9	291.1	96.8	200.3	3.79	3.28	1.45	1.85	0.15	0.15	140	105
Plastics (355-6)	18.2	31.4	33.5	57.2	2.03	0.89	0.71	0.43	0.14	0.10	227	210
Mineral product (36)	17.7	34.1	27.7	53.2	2.60	1.64	0.95	1.14	0.17	0.14	352	304
Metals (37)	273.1	486.7	244.0	343.2	2.50	1.10	1.30	0.82	0.11	0.09	89	70
Metal product (381)	13.7	25.8	31.2	50.5	1.86	0.74	0.50	0.42	0.12	0.11	704	669
Machinery (382)	44.9	148.0	70.5	176.8	2.13	1.03	0.44	0.33	0.10	0.13	501	421
Electrical equipment (383)	43.8	128.3	79.0	190.9	2.07	0.94	0.45	0.38	0.10	0.13	214	195
Transport equipment (384)	30.7	61.2	62.8	123.0	1.86	0.89	0.41	0.34	0.08	0.13	455	429

Footnotes: 1) Mill. Nkr
2) 10^5 Nkr

Table 2. Results from specfication test for the choice of instrument. Hansen's (1982) overidentification test with a Chi-square distribution

Model	D.o.f[1]	Textiles (321)	Clothing (322-4)	Wood products (331)	Furniture (332)	Paper (341)	Printing (342)	Chemicals (351-2)	Plastics (355-6)	Mineral products (36)	Metals (37)	Metal products (381)	Machinery (382)	Electrical equipment (383)	Transport equipment (384)
I	196	199.2	201.4	232.5	200.7	122.2	252.5**	154.9	212.0	217.2	97.8	241.9	244.3*	191.8	179.4
II	160	163.6	171.5	180.3	158.0	121.8	208.3**	156.4	181.6	169.2	95.4	170.1	197.9*	161.4	158.2
III	124	121.5	136.2	156.0*	133.0	122.2	187.4**	132.6	133.0	154.3*	97.9	153.6*	146.0	128.0	126.4
IV	106	103.3	116.7	132.3*	109.4	112.8	156.7**	124.4	115.3	124.8	98.5	134.7*	116.3	109.8	111.4
V	88	87.3	93.2	107.0	101.5	101.9	119.1*	103.9	86.8	101.8	90.9	105.9	94.9	94.7	96.3
I vs. II	36	35.6	29.9	52.2*	42.6	0.4	44.2	0.0[2]	30.5	47.9	2.5	71.8**	46.5	30.4	21.2
II vs. V	72	76.2	78.3	73.3	56.6	19.9	89.2	52.5	94.8*	67.4	4.5	64.2	103.5*	63.9	61.9
I vs. III	72	77.7	65.2	76.6	67.7	0.0	65.1	22.3	79.0	62.8	0.0[2]	88.2	98.3*	18.1	53.0
III vs. IV	18	18.2	19.5	23.6	23.4	9.4	30.7*	8.2	17.7	29.5*	0.0[2]	18.9	29.8*	18.2	15.0
IV vs. V	18	15.9	23.5	25.3	7.9	10.9	37.5**	20.6	28.5	23.0	7.6	28.8	21.9	15.1	15.1
#Obs		1733	1363	5594	1996	926	5966	1094	1758	2571	730	5508	3596	1690	3600
#Plants		258	230	867	285	123	888	157	267	400	100	888	603	264	581

Footnotes: 1) Degrees of freedom.
2) The difference-test statistic was negative.
* Test rejects at 5 % level.
** Test rejects at 1 % level.

Table 3. Estimated price-cost margins and scale economies from the preferred specifications

Model	Textiles (321)	Clothing (322-4)	Wood products (331)	Furniture (332)	Paper (341)	Printing (342)	Chemicals (351-2)	Plastics (355-6)	Mineral products (36)	Metals (37)	Metal products (381)	Machinery (382)	Electrical equipment (383)	Transport equipment (384)
Markup	1.043	1.059	1.084	1.046	1.083	0.659	0.969	1.048	1.074	1.097	1.068	1.043	1.058	1.041
	(.003)	(.003)	(.013)	(.005)	(.034)	(.034)	(.004)	(.015)	(.018)	(.008)	(.016)	(.024)	(.006)	(.006)
Scale	0.977	0.996	0.962	0.974	1.004	0.656	0.882	0.919	0.938	1.013	0.970	0.953	0.967	0.992
	(.003)	(.003)	(.013)	(.005)	(.005)	(.030)	(.004)	(.014)	(.010)	(.009)	(.015)	(.024)	(.005)	(.006)
Overidentification-test[1]	192.2	201.4	180.3	2007	122.2	119.1[2]	154.9	133.0	169.2	97.8	170.1	116.3	191.8	179.4
	(196)	(196)	(160)	(196)	(196)	(88)	(196)	(124)	(160)	(196)	(160)	(106)	(196)	(196)
Instrument set [3]	I	I	II	I	I	V	I	III	II	I	II	IV	I	I
#Obs.	1733	1363	5594	1996	926	5966	1094	1758	2571	730	5508	3596	1690	3600
#Plants	258	230	867	284	123	888	157	267	400	100	888	603	264	581

Footnotes:
1) Hansen's (1982) overidentification-test with a Chi-square distribution. Degrees of freedom in parentheses.
2) Overidentification-test rejects at 5% level.
3) Preferred instrument set (see table 2):
   - I: All leads and lags.
   - II: Non-contemproanous IVs.
   - III: Predetermined IVs dated t and earlier.
   - IV: Predetermined IVs dated t-1 and earlier.
   - V: Predetermined IVs dated t-2 and earlier.

Table 4. Parameter variances and covariances. Estimates from regressions on cross-products of residuals[1]

Model	Textiles (321)	Clothing (322-4)	Wood products (331)	Furniture (332)	Paper (341)	Printing (342)	Chemicals (351-2)	Plastics (355-6)	Mineral products (36)	Metals (37)	Metal products (381)	Machinery (382)	Electrical equipment (383)	Transport equipment (384)
σ_a^2	0.018*	0.018*	0.009*	0.007*	0.043*	0.011*	0.022*	0.001	0.012*	0.021*	0.013*	0.017*	0.014*	0.012*
	(.002)	(.002)	(.001)	(.001)	(.010)	(.005)	(.010)	(.005)	(.002)	(.003)	(.001)	(.002)	(.003)	(.001)
σ_μ^2	0.001	0.003	0.005*	0.012*	0.0[2]	0.222*	0.035*	0.044*	0.005	0.003	0.001	0.005	0.001	0.002
	(.003)	(.002)	(.002)	(.003)	(-)	(.019)	(.015)	(.012)	(.005)	(.004)	(.001)	(.004)	(.005)	(.001)
σ_η^2	0.001	0.004*	0.002*	0.001	0.0[3]	0.131*	0.024*	0.029*	0.004	0.0[2]	0.000	0.005*	0.003*	0.001*
	(.001)	(.002)	(.000)	(.001)	(-)	(.005)	(.005)	(.003)	(.002)	(-)	(.000)	(.001)	(.001)	(.001)
$\sigma_{a\mu}$	-0.004	-0.004*	-0.001	-0.003*	-0.007	-0.020*	-0.017*	-0.016*	-0.001	-0.006*	-0.001	-0.001	-0.002	-0.003*
	(.002)	(.002)	(.001)	(.001)	(.005)	(.005)	(.009)	(.002)	(.002)	(.003)	(.001)	(.003)	(.002)	(.001)
$\sigma_{a\eta}$	-0.004*	-0.005*	-0.003*	-0.003*	0.002	-0.025*	-0.014*	-0.017*	-0.006*	-0.001	-0.002*	-0.009*	-0.001	-0.003*
	(.002)	(.002)	(.000)	(.001)	(.003)	(.003)	(.006)	(.002)	(.002)	(.001)	(.001)	(.001)	(.001)	(.000)
$\sigma_{\mu\eta}$	0.001	0.003	0.002*	0.000	-0.005*	0.168*	0.035*	0.023*	0.002	0.000	0.001	0.001	0.004	0.000
	(.002)	(.002)	(.001)	(.002)	(.002)	(.011)	(.008)	(.006)	(.002)	(.001)	(.001)	(.002)	(.002)	(.001)

Footnotes: 1) Heteroscedasticity-robust standard errors in parentheses.
2) Negative variance estimate, not significantly different from zero.
3) Negative variance estimate, significantly below zero.
* Significantly different from zero at the 5% level.

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